

Reducing Energy Cost

Optimizing Performance through Energy Efficiency Best Practices

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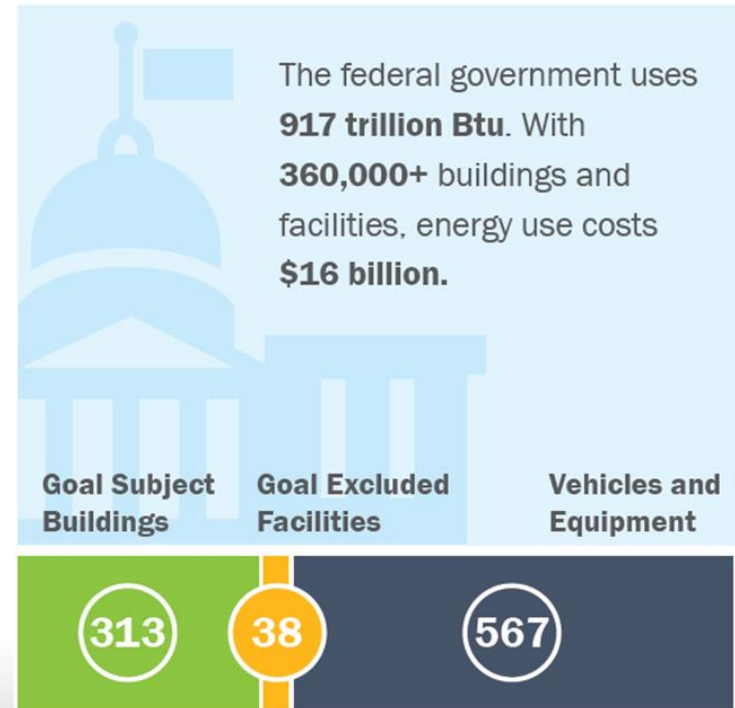


Agenda

- **DOE's Federal Energy Management Program**
 - **Challenges and Opportunities**
 - DOE's data center (HPC) growth
 - Best practice benchmarking
 - A continuous improvement process
 - Efficiency best practices to optimize and reduce cost
 - **LBNL's Center of Expertise – Technical Assistance & Resources**
- Next Month**

 - **Team Approach to Energy and Cost Saving Opportunities**
 - LBNL's continuous improvement process save big \$
 - **Tools and Resources**

Federal Government's Potential



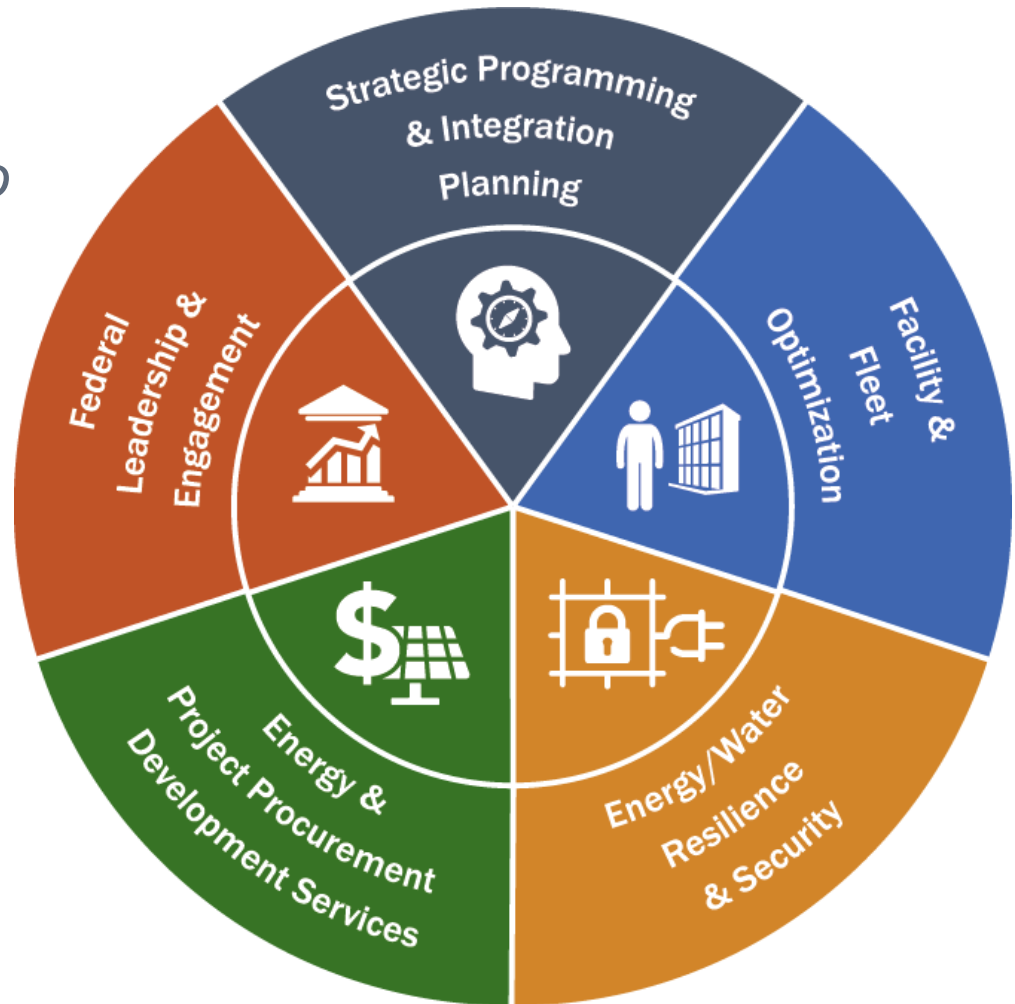
\$151 billion of deferred maintenance and repairs is required to bring government owned property, and equipment to an acceptable condition.

Between **\$9 billion** and **\$15 billion** of potential self-financing efficiency measures exist in Federal buildings.



Federal Energy Management Program

Providing strategic energy management for agencies to become resilient, efficient and secure in support of Administration priorities for American Energy Dominance, Increased Government Accountability and Development of a Future-Focused Workforce.



Performance Contracting Delivers Results

FY 2018 DOE ESPC IDIQ

\$809 Million Record Investment by Federal Agencies in Support of Increased Resilience



LEADERSHIP: Government Efficiency

10 AGENCIES

Environmental Protection Agency	U.S. Air Force
Federal Aviation Administration	U.S. Department of Energy
Federal Bureau of Prisons	U.S. Navy
General Services Administration	U.S. Office of Personnel Management
National Aeronautics and Space Administration	U.S. Veterans Affairs



FOCUS: Retrofits for Resilience

Replacing Aged Equipment with Highly Efficient Equipment

Incorporating Combined Heat & Power, Microgrids, & Battery Storage to Address \$165 Billion of Deferred Maintenance



INVESTMENTS: Strengthen Infrastructure

Highly Efficient Equipment Enables Almost **\$1.7 Billion in Energy & Water Savings**



IMPACT: Jobs

Good Jobs in Engineering, Construction, & Manufacturing

6,475 Job Years Created

Webinar: Opportunities For ESPCs In Data Centers

Thursday, May 21 1:00 – 2:30 PM EST

<https://www.wbdg.org/continuing-education/femp-courses/femplw05212020>

FEMP's Data Center Program



FEMP's Data Center program assists federal agencies and other organizations with optimizing the design and operation of data centers. design and operation of energy and water systems in data centers to enhance agency's mission.

Assistance

- Project and technical assistance from the [Center of Expertise](#) for Energy Efficiency in Data Center
- Support agencies in meeting OMB's Data Center Optimization Initiative requirements

Tools

- [Data Center Profiler \(DC Pro\) Tools](#), including PUE Estimator
- [Air Management Tools](#)
- [Energy Assessment Worksheets](#)

Key Resources

- [Better Buildings Data Center Challenge and Accelerator](#)
- [Small Data Centers, Big Energy Savings: An Introduction for Owners and Operators](#)
- [Data Center Master List of Energy Efficiency Actions](#)

Training

- [Better Buildings webinar series](#)
- [Ten on-demand FEMP data center trainings](#)
- [Center of Expertise Webinars](#)
- [Data Center Energy Practitioner](#) Trainings

Data Center Energy

Data centers are energy intensive facilities

- 10 to 100+ times more energy intensive than an office
- Server racks now designed for more than 30 kW
- Surging demand for data processing and storage
- 1.8% of US electricity consumption
- Power and cooling constraints in existing facilities
- Perverse incentives –
 - ✓ IT and facilities costs separate

Potential Benefits of Energy Efficiency

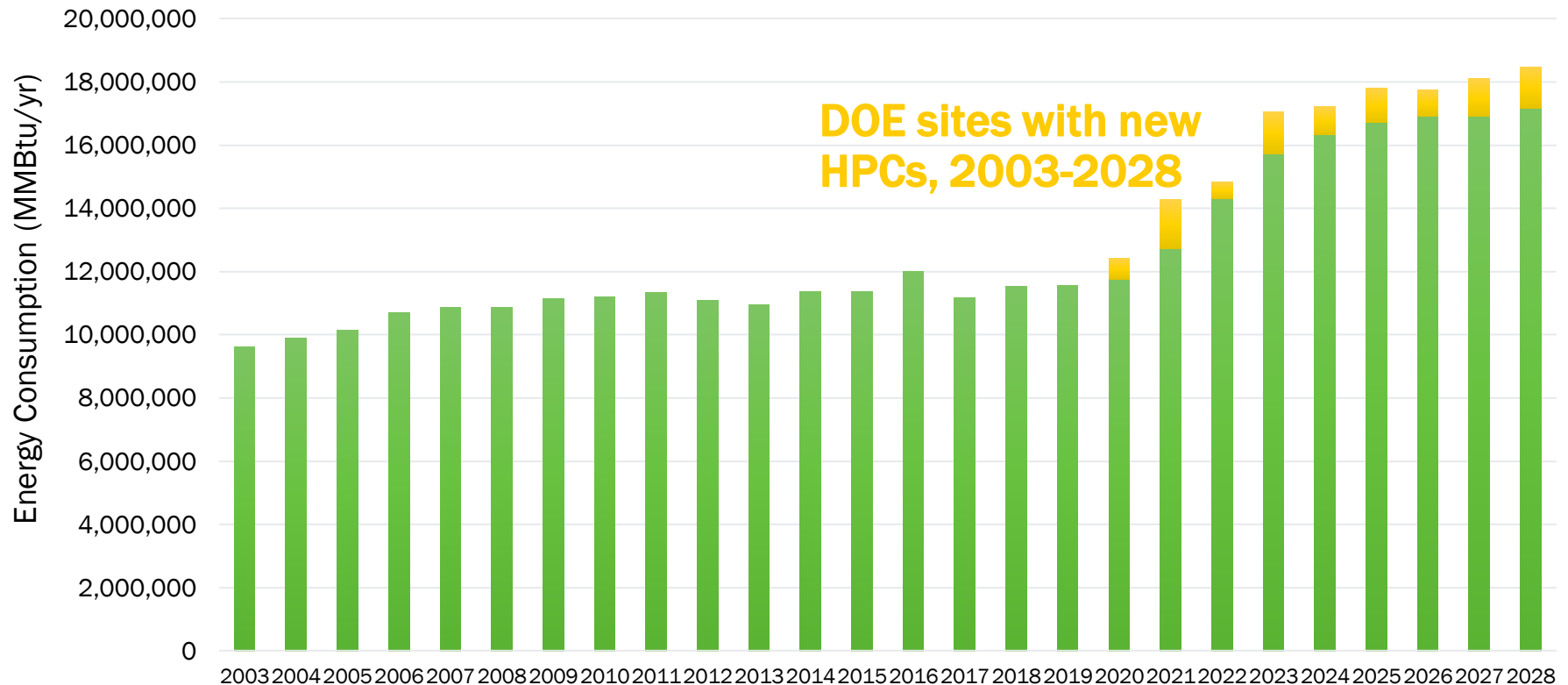
- 20-40% savings & high ROI typical
- Aggressive strategies can yield 50+% savings
- Extend life and capacity of infrastructures
- Increased resiliency



Projected Energy at 8 DOE National Labs

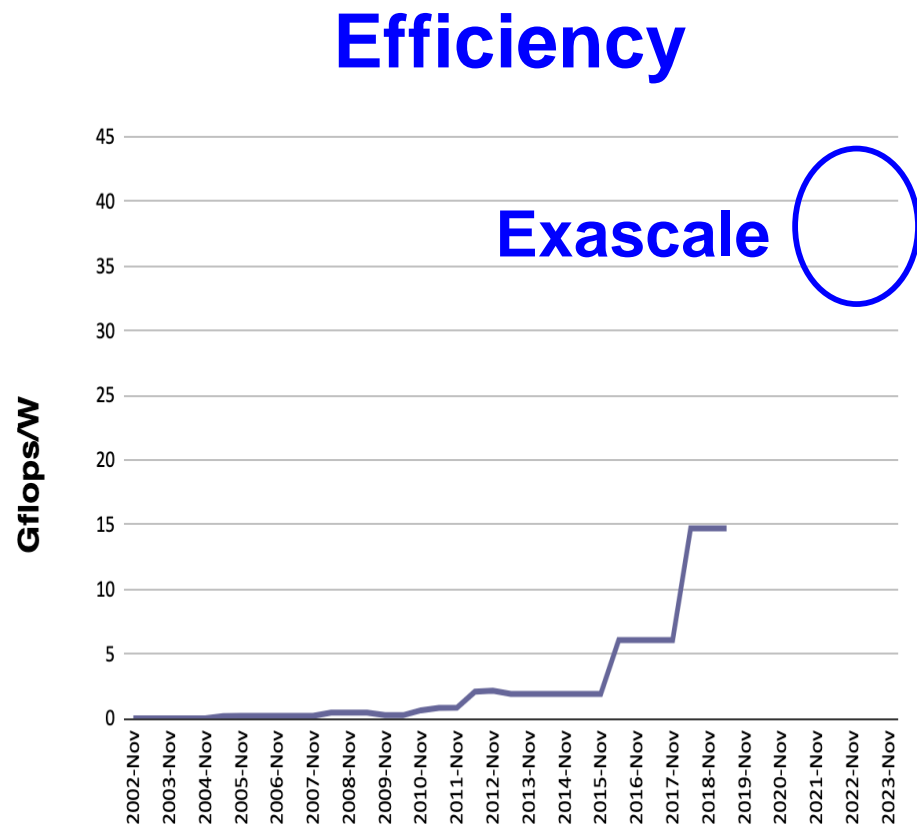
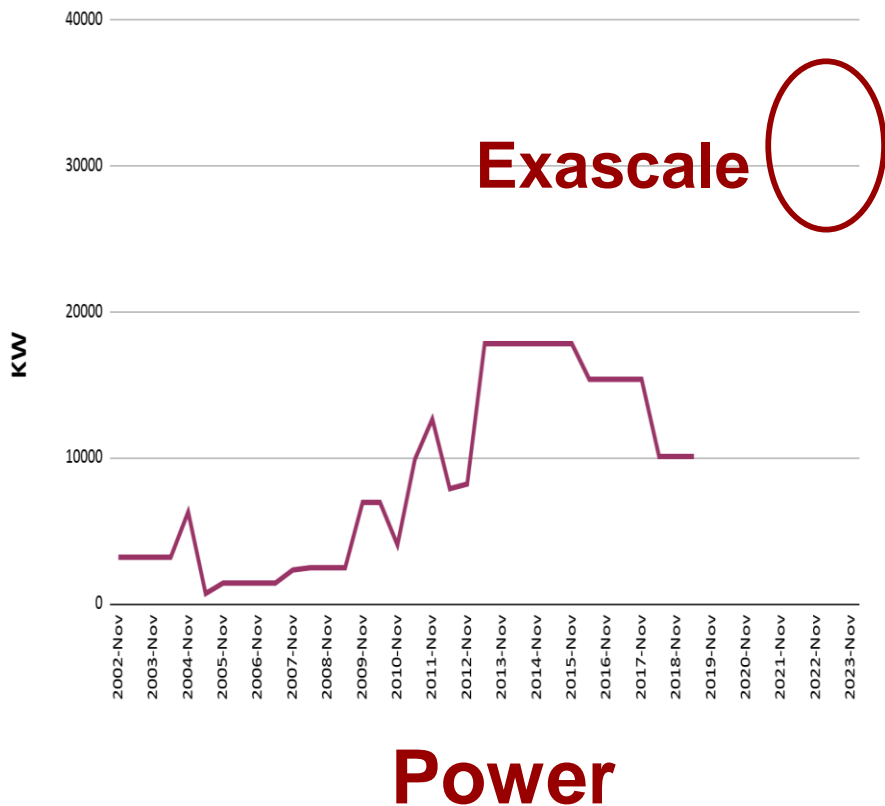
DOE sites with new HPCs, 2003-2028

Potential Data Center Impact on Energy Consumption



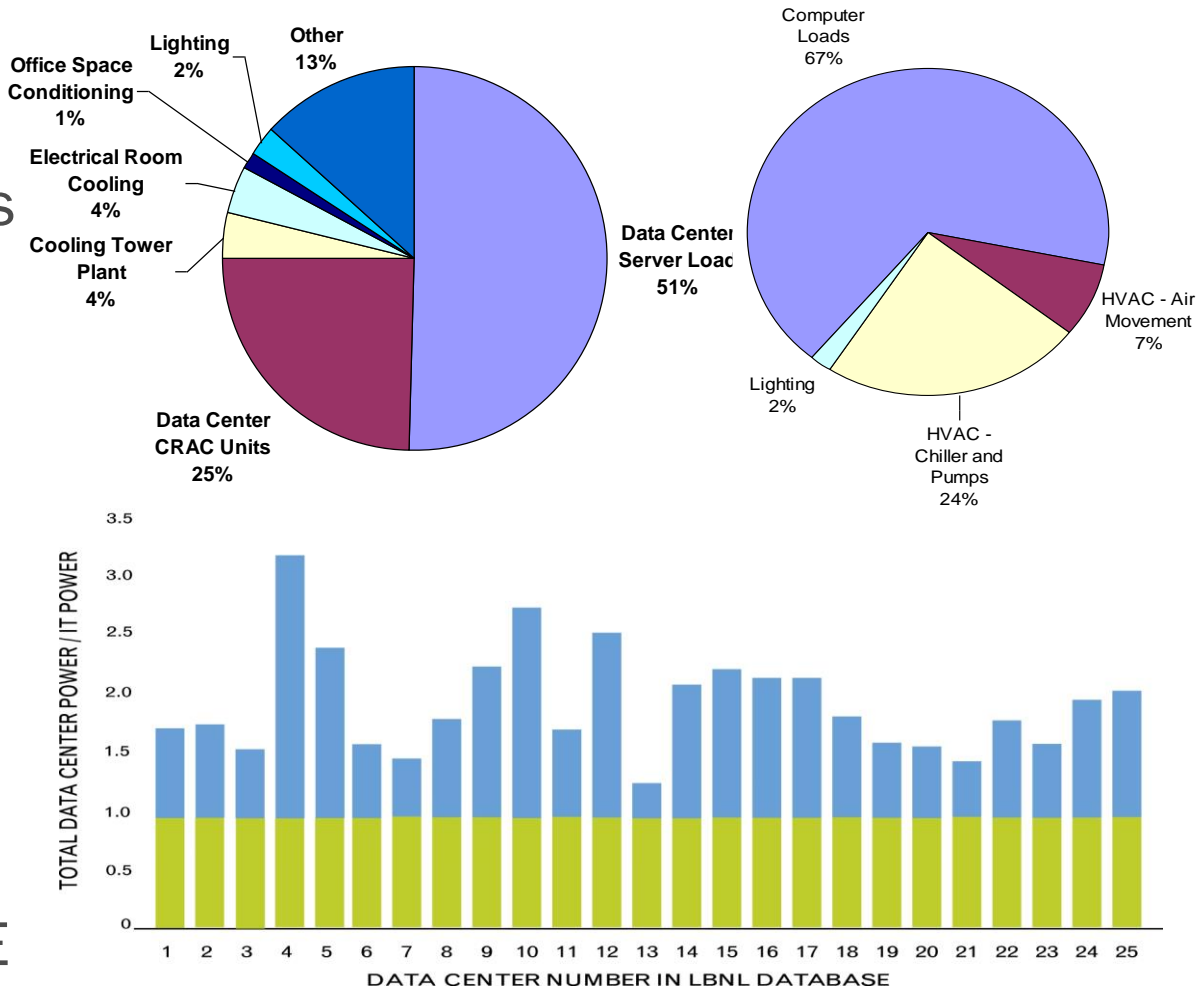
Please note the energy consumption data in this chart is for sites with planned/new large data centers/HPCs only: ANL, LANL, LBL, LLNL, NREL, NETL, ORNL and SNL. Information is based on FY 2019 reported data and does not reflect current status. Increase due to HPC is in dark blue.

Power and Efficiency of Top Supercomputer



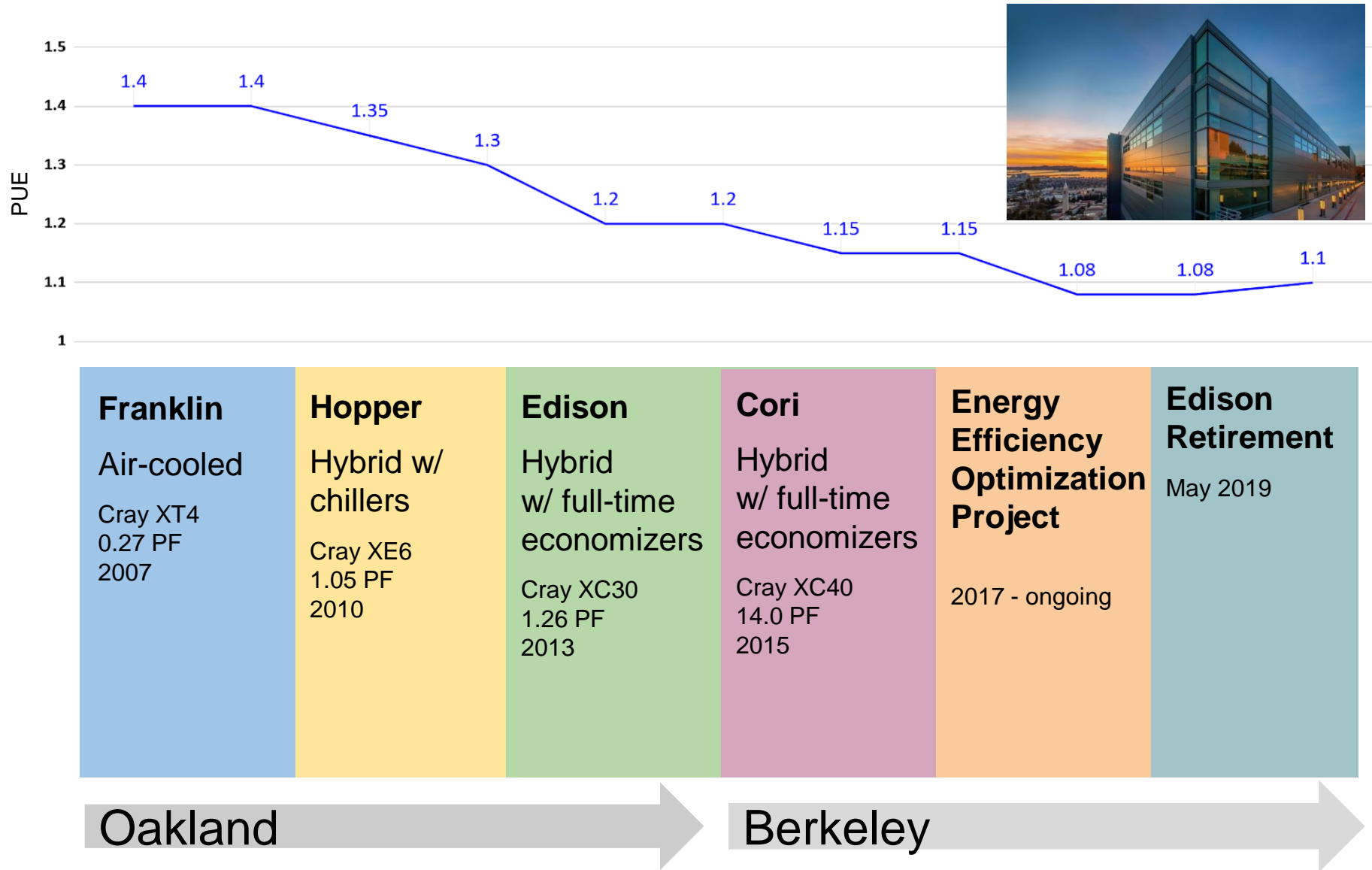
First Step: Benchmark Energy Performance

- Compare to peers
 - Wide variation
- Identify best practices
- ID opportunities
- Track performance
 - Can't manage what isn't measured
- The relative percentage of energy actually doing computing varies
- High level Metric: PUE

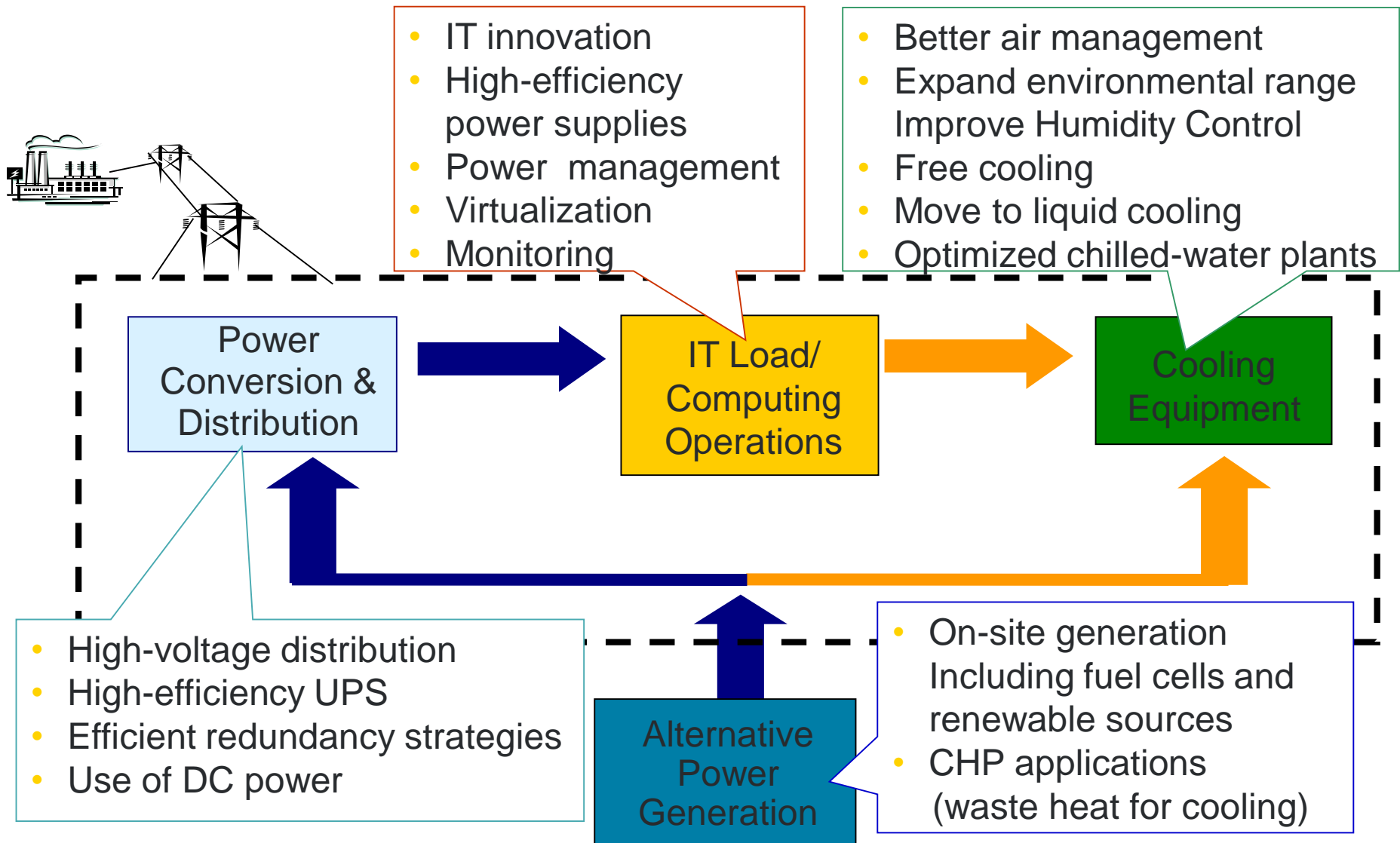


$$\text{Power Utilization Effectiveness (PUE)} = \text{Total Power} / \text{IT Power}$$

No Silver Bullet - Just Continuous Improvement

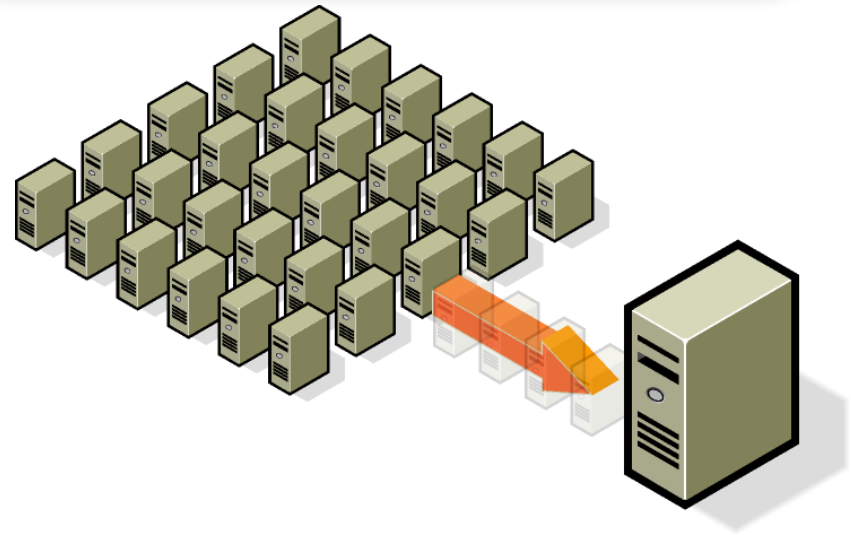
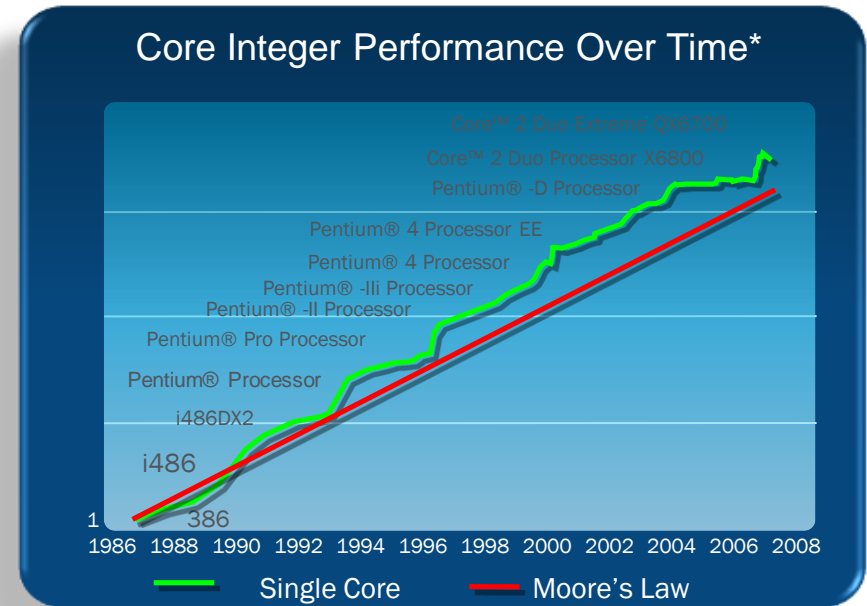


Data Center Energy Efficiency Opportunities



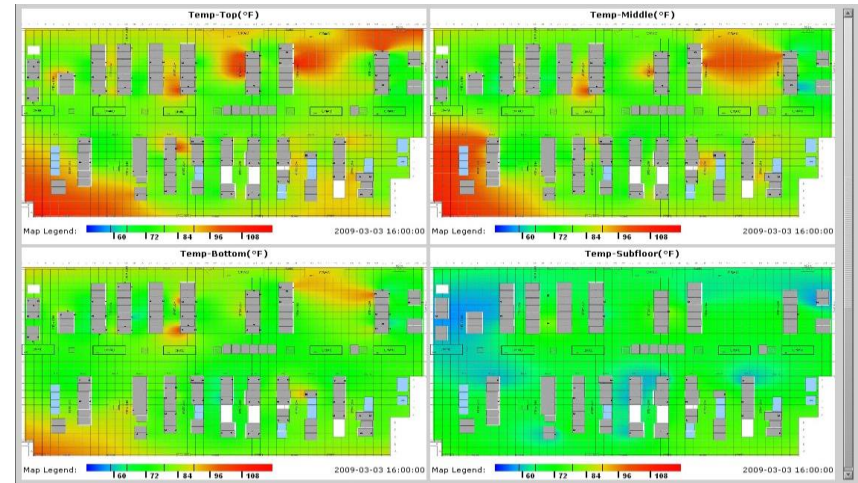
IT Load/Computing Operations

- Increase Computations/Watt
- IT Equipment Efficiency
 - Use ENERGY STAR
 - Use efficient power supplies and optimize redundancy
 - Enable power management (e.g., sleep mode)
- Virtualize for higher utilization
- Reducing IT load has a multiplier effect
 - Savings in infrastructure energy depends on PUE



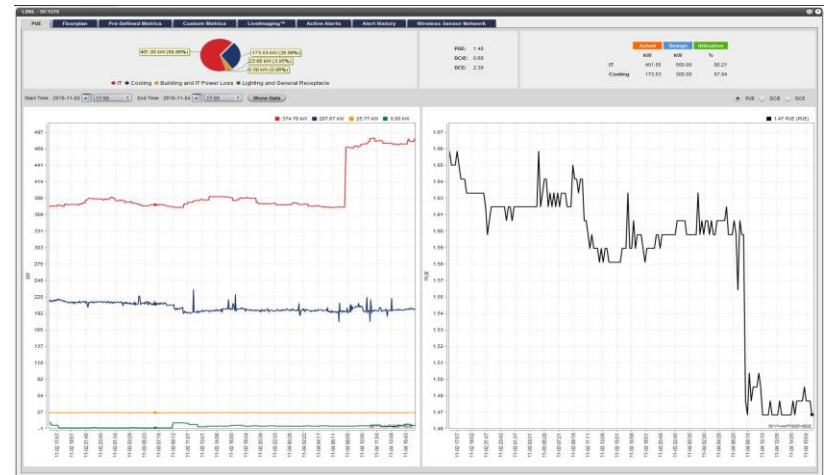
Enhance Monitoring: Using IT to Save Energy in IT

- Operators lack visibility into data center environment
- Provide same level of monitoring and visualization of the physical space as we have for the IT environment
- Measure and track performance
- Spot problems early
- Example: 800 pt system at LBNL



LBNL Wireless Monitoring System

source: SynapSense

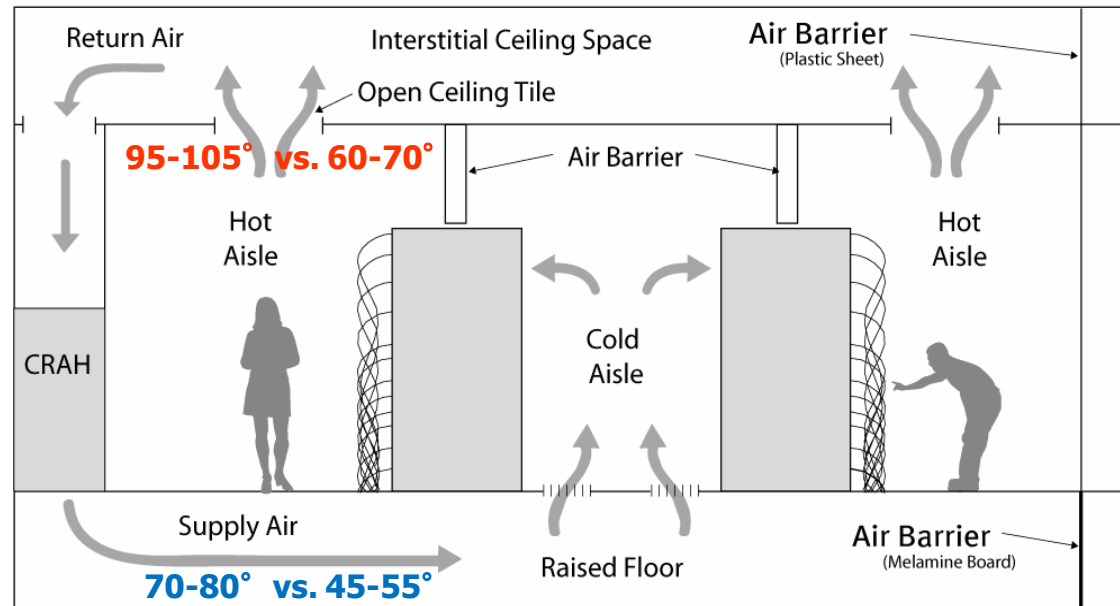


Real-time PUE Display

Cooling with Better Air Management

- Typically, more air circulated than required
- Air mixing and short circuiting leads to:
 - Low supply temperature
 - Low Delta T
- Use hot and cold aisles
- Improve isolation of hot and cold aisles
 - Reduce fan energy
 - Improve air-conditioning efficiency
 - Increase cooling capacity

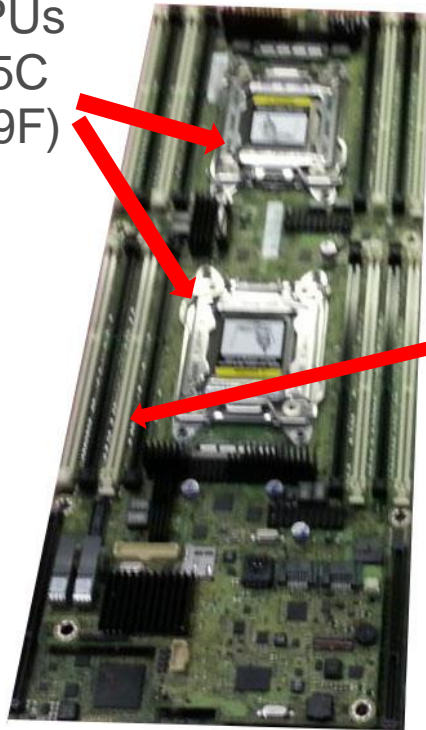
Isolate Cold and Hot Aisles



Environmental Conditions: Safer Limits and Guidelines

CPU, GPU & Memory, represent
~75-90% of heat load ...

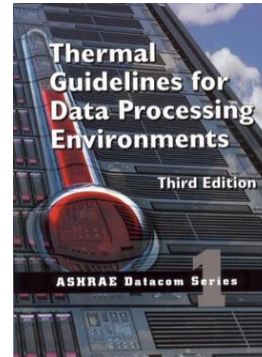
CPU
~65C
(149F)



GPU
~75C
(167F)

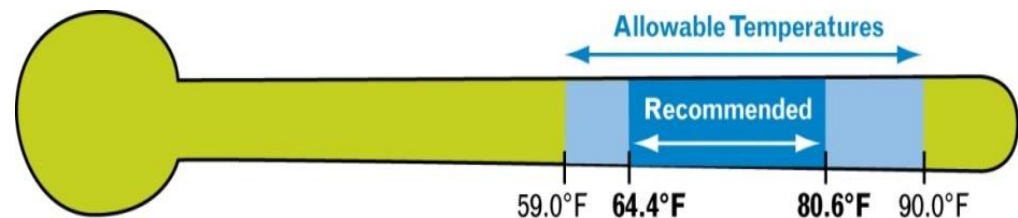
Memory
~85C
(185F)

ASHRAE Thermal Guidelines



- Provides common understanding between IT and facility staff
- Provides wider humidity ranges
- Recommends temperature range up to 80.6° F with “allowable” much higher, up to 113° F.

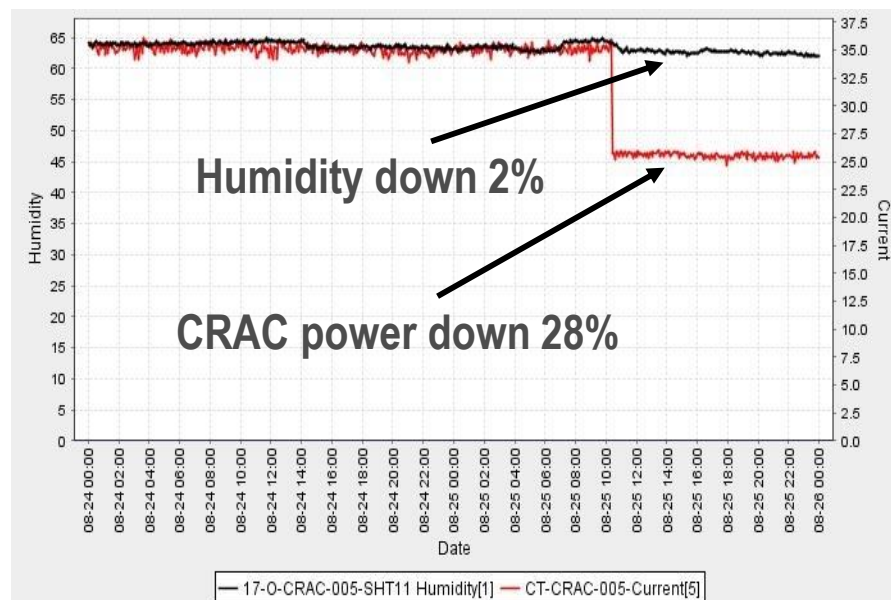
So why do we need
jackets in data centers?



Humidity Control & Cost

	Visalia Probe			CRAC Unit Panel			
	Temp	RH	Tdp	Temp	RH	Tdp	Mode
AC 005	84.0	27.5	47.0	76	32.0	44.1	Cooling
AC 006	81.8	28.5	46.1	55	51.0	37.2	Cooling & Dehumidification
AC 007	72.8	38.5	46.1	70	47.0	48.9	Cooling
AC 008	80.0	31.5	47.2	74	43.0	50.2	Cooling & Humidification
AC 010	77.5	32.8	46.1	68	45.0	45.9	Cooling
AC 011	78.9	31.4	46.1	70	43.0	46.6	Cooling & Humidification
Min	72.8	27.5	46.1	55.0	32.0	37.2	
Max	84.0	38.5	47.2	76.0	51.0	50.2	
Avg	79.2	31.7	46.4	68.8	43.5	45.5	

- Eliminate inadvertent dehumidification
 - Computer load is sensible only
- Use ASHRAE allowable RH and temperature
 - Many manufacturers allow even wider humidity range
- Eliminate equipment fighting
 - Coordinate controls
 - Turn off



Use Free Cooling

Cooling without Compressors

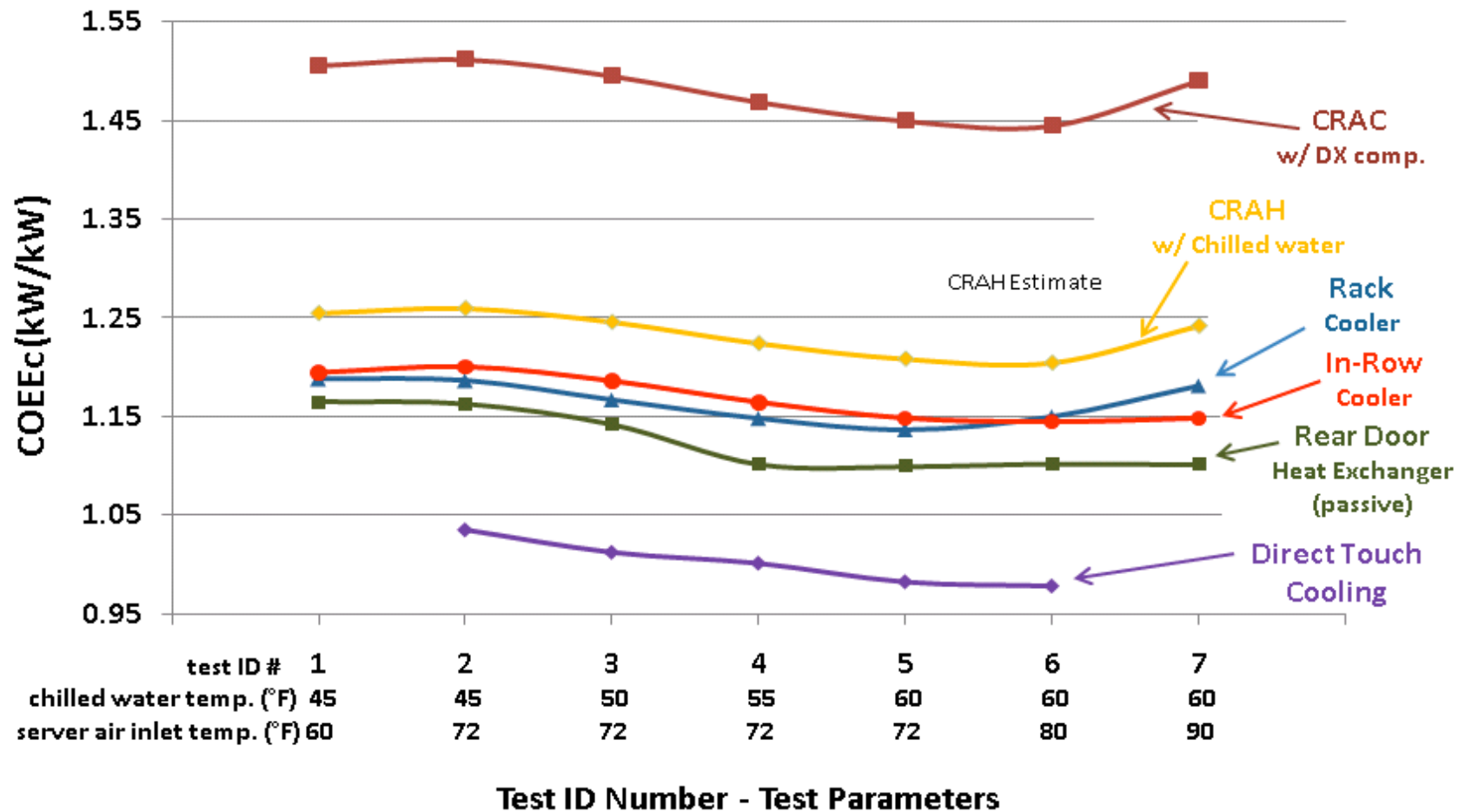
- Water-side Economizers
- Outside-Air Economizers



**Let's get rid of
chillers in data
centers**

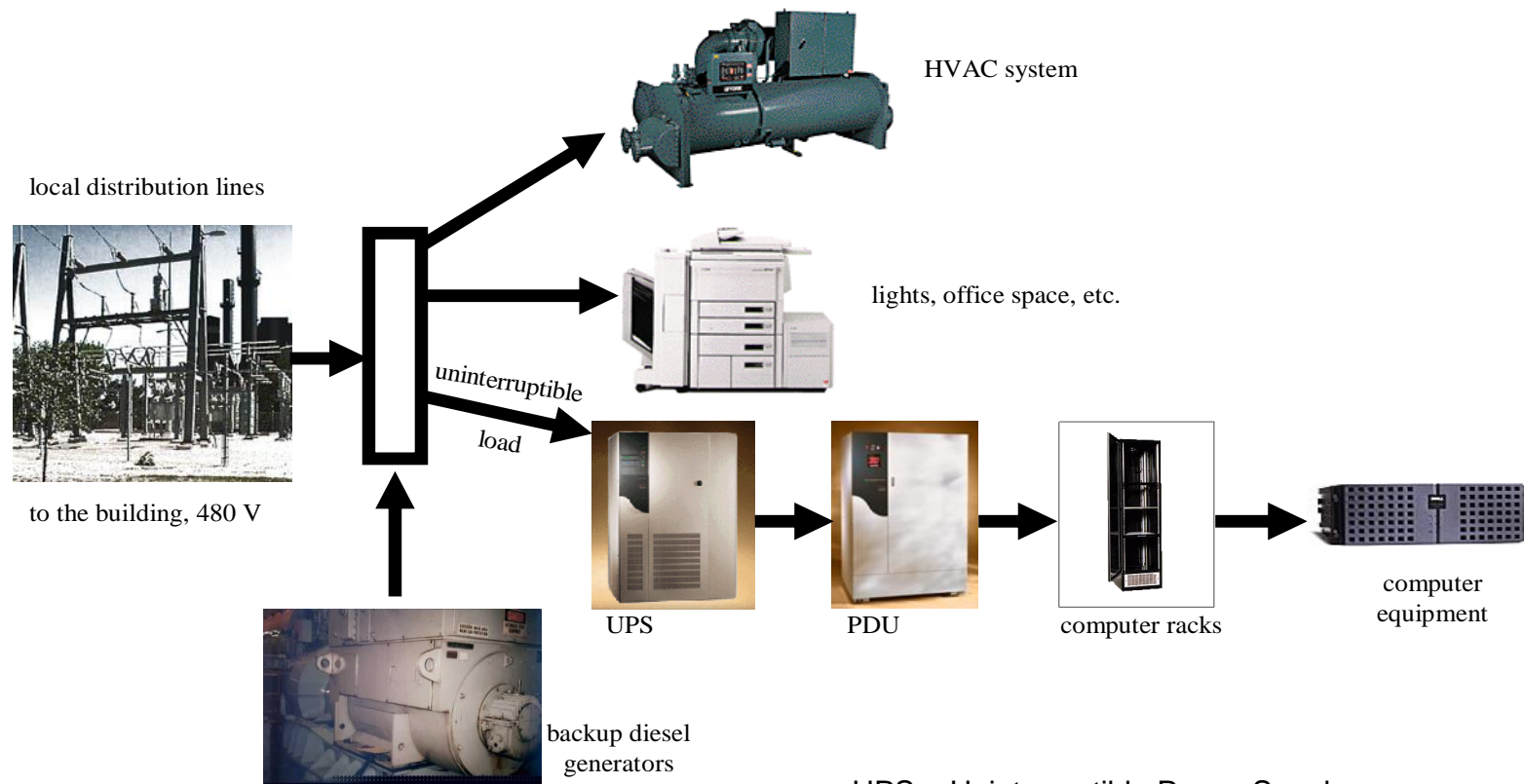
Data Center Opportunity: Getting Liquid Closer

Data Center Cooling Device Relative Performance



Power Conversion and Distribution

Electricity Flows in Data Centers

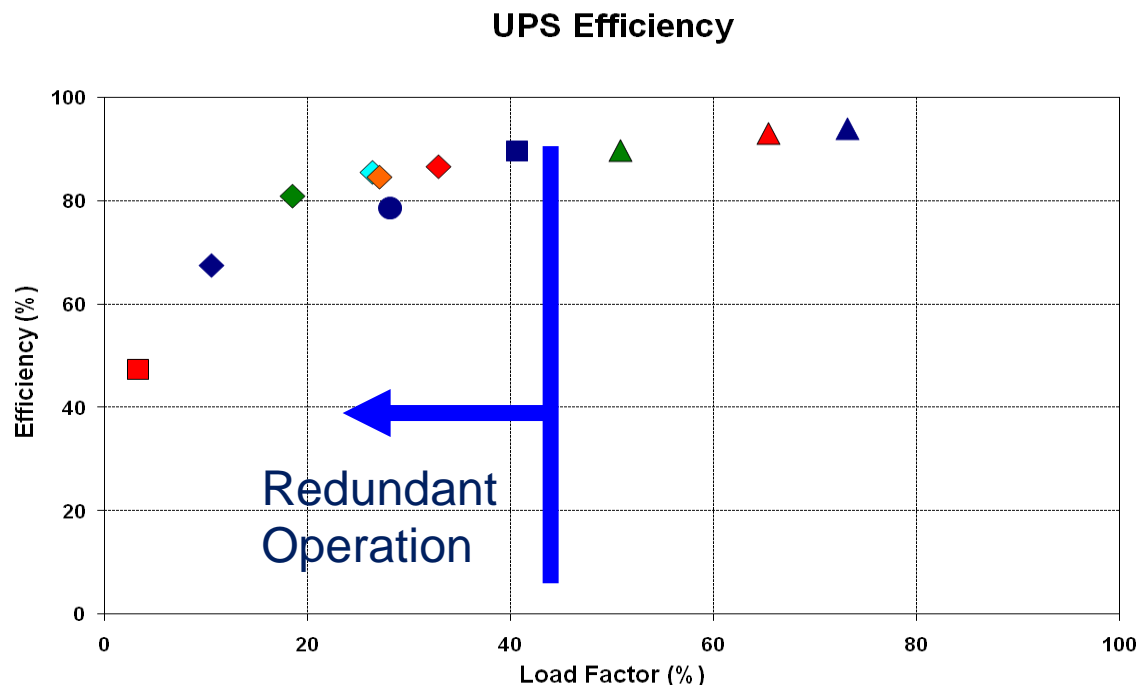


UPS = Uninterruptible Power Supply

PDU = Power Distribution Unit;

Power Conversion and Distribution

- Increase voltage distribution
- Buy high-efficiency, modular (scalable), UPS
- Use efficient redundancy strategies
 - Different strategies have different energy penalties (e.g. $2N$ vs. $N+1$)
 - Redundancy in electrical distribution puts you down the efficiency curve
 - Consider redundancy in the network rather than in the data center



Best Practices Summary

1. Identify IT Equipment and Software Opportunities
2. Use IT to Monitor and Control IT (+ M&V)
3. Manage Airflow
4. Optimize Environmental Conditions, e.g. Humidity
5. Evaluate Cooling Options including Free Cooling and Liquid Cooling
6. Improve Electrical Efficiency – Power Conversion and Distribution

Overcoming Barriers to Success

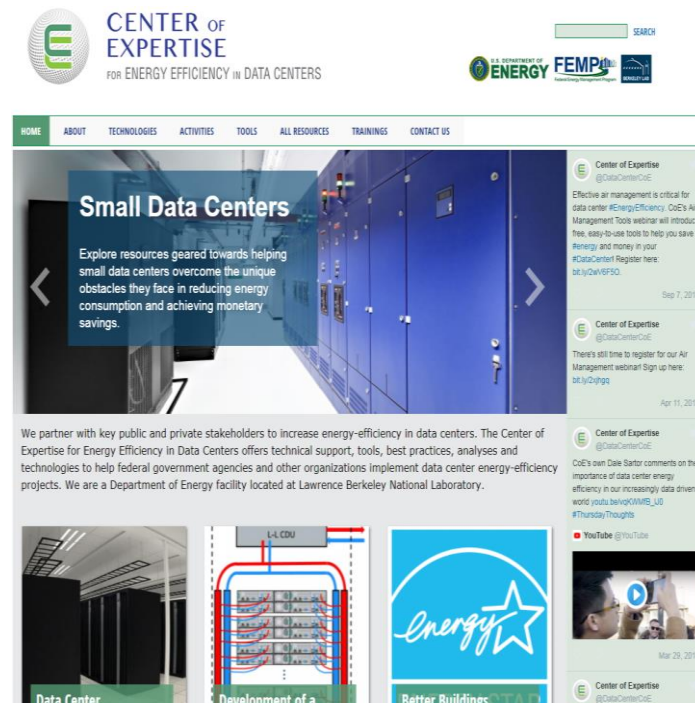
- **Barriers to success**
 - Organizational Inertia, conflicting goals, and risk aversion
 - Lack of funding
 - Lack of manpower / expertise
- **FEMP can help overcome these barriers**
 - Technical Resources and Assistance
 - ESPC and UESC (attend upcoming ESPC webinar)

Get IT and Facilities people talking and working together as a team!!!

Data Center Services for Federal Agencies

FEMP provides the following data center services through the Center of Expertise for Energy Efficiency in Data Centers:

- Project Assistance
- Tools
- Resources
- Training



<https://datacenters.lbl.gov/>

Visit the FEMP training website for upcoming data center webinars:

<https://www4.eere.energy.gov/femp/training/>

FEMP is Ready to Help!



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